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SILICIFIED WOOD FROM THE TRIASSIC OF PENNSYLVANIA.

BY EDGAR T. WHERRY, PH.D.¹

The occurrence of silicified wood in the Triassic or "Newark" rocks of the eastern United States was first observed in the Richmond Basin, Virginia, by Thomas Nuttall in 1821,² and it was shortly afterward discovered in North Carolina³ and in Connecticut,⁴ but its presence in Pennsylvania does not appear to be mentioned in the literature.⁵

The inhabitants of southern Bucks and northern Chester and Lancaster Counties have long recognized the character of specimens of it plowed up in their fields, but its scientific interest was first realized by Mr. John F. Vanartsdalen, of Holland, Bucks County, about 1890, who brought it to the attention of the writer several years later. The western Lancaster County occurrences were discovered independently by Professor H. Justin Roddy, of the Millersville State Normal School. Subsequent search has greatly increased the number of localities, so that it is now known to occur at short intervals along the strike of the Triassic rocks, near their base—the southern edge of the belt, since the dip is for the most part gently northward—from the Delaware River to beyond the Susquehanna, a distance of over 100 miles. These relations are well brought out in the accompanying sketch map and geographical table.

TABLE I. LOCALITIES OF SILICIFIED WOOD.

B. *Bucks County.*

1. Roelofs: Farm of George W. DeCoursey, $\frac{1}{4}$ mile southeast of the station.
2. Woodbourne: On several farms $1\frac{1}{2}$ miles north of the station.

¹ This paper, the fourth of the writer's studies on the Triassic, was presented in preliminary form at the meeting of the Academy in association with the Mineralogical and Geological Section on May 18, 1909, but publication was deferred until opportunity for completing the work could be obtained, the final results being announced at the similar meeting on May 21, 1912.

² Observations on the Geological Structure of the Valley of the Mississippi, [etc.], *Jour. Acad. Nat. Sci. Phila.*, II, i, p. 37.

³ Olmsted, D. Descriptive Catalogue of Rocks and Minerals Collected in North Carolina, *Amer. Jour. Sci.*, [1], V, p. 261, 1822.

⁴ Hitchcock, E. Miscellaneous Notices of Mineral Localities, with Geological Remarks, *Amer. Jour. Sci.* [1], XIV, p. 228, 1828.

⁵ Compare, however, Prof. O. C. S. Carter: A Ferruginised Tree, *Jour. Franklin Inst.*, CXXI, pp. 227–229, 1896, which perhaps refers to similar material.

3. Newtown: Bed of Neshaminy Creek, $1\frac{1}{2}$ miles west of the town.
4. St. Leonard's: Roadside northeast of station.
5. Rockville (Holland P. O.): Fields along north bank of Mill Creek.
6. Holland: Fields south and southeast of the station.
7. Churchville: Fields east of station.
8. Center Hill: Fields along ridge just northwest of village and for 2 miles southwestward.
9. Spring Valley: Fields 1 mile to the southwest.
10. Doylestown: Fields $1\frac{1}{2}$ miles south of the town.

M.

Montgomery County.

1. Morganville: Trenton Cut-Off R. R. cut $\frac{1}{4}$ mile east of station.
2. Jarretstown: Sand quarry $\frac{1}{2}$ mile northwest of cross-roads.
3. Maple Glen: Sand quarry south of house of William Teas, $\frac{1}{4}$ mile east of cross-roads; this is the "ferruginized tree" locality.

C.

Chester County.

1. Sheeder: Roadside $\frac{3}{4}$ mile northeast of cross-roads.
2. Coventryville: Fields on farm of Isaac D. Rosen, $\frac{1}{4}$ mile east of the village.

L.

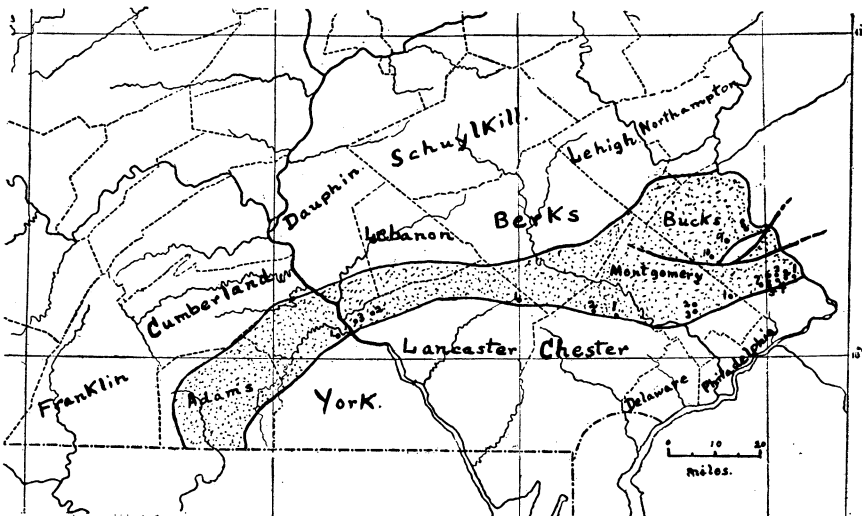
Lancaster County.

1. Churchtown: Fields 2 miles northwest of town.
2. Elizabethtown: Penna. R. R. cut $\frac{1}{2}$ mile southeast of station; also in fields east and southwest of town.
3. Bainbridge: On several farms about 3 miles to the northeast; and on that of Omar Baughman, one mile north of the town.

Y.

York County.

1. York Haven: In fields about 2 miles to the south and southeast.



The wood occurs in fragments of all sizes, up to complete trunks a foot or more in diameter and several feet long. It is usually dark brown in color, and almost entirely replaced by granular to minutely crystalline quartz,⁶ with occasional carbonaceous streaks. Its original vegetable character is almost always evident to the naked eye, although annual rings are never visible; and thin sections, which are readily prepared by grinding with carborundum, after the manner of making ordinary rock-sections, show under the microscope every structural detail beautifully outlined in brown. While usually found loose in the fields or along the roads, it has been observed in place in several localities, and is always associated with the highly arkosic sandstones or conglomerates which mark the lower portions (Norristown or Stockton formation) of the Triassic. It is not limited to any narrow horizon, however, but occurs at various levels throughout a thickness of at least 5,000 feet of beds, locality M. 1, for instance, being at the very base, and B. 3 at the top, of that formation.

The material found outside of Pennsylvania has all been referred to three species, *Araucarioxylon virginianum*, *A. woodworthi*, and *Cedroxylon huttonianum*?, the first being the most widely distributed. As a result of the examination of some sixty specimens, about half of which were sectioned by Mr. Vanartsdalen, two new species have been recognized, which are here described as *Araucarioxylon vanartsdalenii* and *Brachyoxylon pennsylvanianum*. The present paper is not to be regarded as the last word upon the subject, however, as it is possible that the discovery of additional material may throw further light on the status and relationships of these species.

Genus **ARAUCARIOXYLON** Kraus.

Araucarioxylon virginianum Knowlton. Plate III, figs. 1-3.

Fossil Wood and Lignite of the Potomac [and Newark] Formation, Bull. U. S. Geol. Surv., No. 56, pp. 50-52, pl. VII, 1889. A Revision of the Genus *Araucarioxylon* of Kraus, Proc. U. S. Nat. Mus., XII, p. 615, 1889, and Amer. Jour. Sci., [3], XL, p. 257, 1890. Report on some Fossil Wood from the Richmond Basin, Virginia, Ann. Rept. U. S. Geol. Surv., XIX, pt. ii, pp. 516, 517, pl. LII, 1899. Description of a Small Collection of Fossil Wood from the Triassic Area of North Carolina, Ann. Rept. U. S. Geol. Surv. XX, pt. ii, pp. 272-274, pl. XXXVII, 1900. Report on Fossil Wood from the Newark Formation of South Britain, Conn. Ann. Rept. U. S. Geol. Surv., XXI, pt. iii, pp. 161, 162, 1901.

TRANSVERSE SECTION: Annual ring indistinct; tracheids thick

⁶Chemical analysis of a Lancaster County specimen (from L. 3) by Prof. Miles Timlin, of the Millersville State Normal School, showed: SiO₂, 96.5%; Fe₂O₃, 1.2%, the remainder being carbonaceous matter. Cf. Pl. IV, fig. 6.

walled, moderately large (about 0.04 mm. in diameter) in radial rows.

RADIAL SECTION: Tracheids long, thick walled; bordered pits in one or frequently two series; when in one, in contact and flattened; in two, closely packed, alternate, strongly hexagonal, and nearly covering the walls of the cells (diam. 0.016 to 0.021 mm.); medullary rays long, without pits; resin ducts none.

TANGENTIAL SECTION: Rays simple, of 1 to 27, usually 10–12 cells about 0.025 mm. in diameter; no pits on walls, but cross-sections of radial wall pits prominent.

OCCURRENCE: This species, hitherto found near the base of the Triassic in North Carolina, Virginia, and Connecticut, is now reported for the first time from Pennsylvania, being occasionally found at localities B. 2 and B. 5.

RELATIONSHIP: *Araucarioxylon* (*Dadoxylon*) *rhodeanum* Göppert, from the Permian of Silesia, appears from descriptions to be very similar to this species, but distinctive features would no doubt be found if well-preserved specimens could be compared.

***Araucarioxylon vanartsdalenii* sp. nov.** Plate III, figs. 3–6.

TRANSVERSE SECTION: Annual ring indistinct; tracheids averaging 0.03 mm. in diameter, thick walled.

RADIAL SECTION: Tracheids long, thick walled, with bordered pits (diam. 0.015–0.020 mm.) usually in single rows, barely touching, and but little compressed; about one cell in every fifty with double rows, which are alternate and hexagonal; medullary rays long (at least, no partitions preserved), without pits; resin ducts absent.

TANGENTIAL SECTION: Ray cells rather small (diam. 0.02 mm.), up to 10 in one row, though usually 5 or 6; pits absent.

OCCURRENCE: This appears to be the most widespread form in the Triassic of Pennsylvania, occurring at practically every locality on the list.

RELATIONSHIP: When first examined all of the wood with contiguous pits was referred to *A. virginianum*, but the study of a large number of specimens indicates that there are probably two distinct species represented, and the one characterized here differs from *A. virginianum* as well as from *A. woodworthi* Knowlton, which occurs near the top of the Triassic in Virginia, in the fewer-celled medullary rays and the predominance of the uniserial arrangement of the pits. It is therefore regarded as new, and named after its discoverer. Its nearest relative in other regions is *A. württemberg-*

iacum Göppert, which is a Jurassic form, but there is no reason to suppose them to be really identical.

Genus **BRACHYOXYLON** Hollick and Jeffrey.

Brachyoxylon pennsylvanianum sp. nov. Plate IV, figs. 1-5.

Cedroxylon ? *pennsylvanianum*, the writer's communication to the Academy, May 18, 1909. *Peuce huttoniana* Witham ? Rogers, W. B.: [Exhibition of Specimens, with Remarks.] Proc. Boston Soc. Nat. Hist., V, pp. 17, 18, 1854.

TRANSVERSE SECTION: Annual ring distinct; tracheids about 0.035 mm. in diameter, medium walled.

RADIAL SECTION: Tracheids long, medium walled; bordered pits, 0.010 to 0.012 mm. in diameter, in one or rarely two series, circular, not quite touching, when double in part distant and sub-opposite, yet in other places in the same sections alternating and hexagonal; medullary rays long, without pits; resin ducts absent.

TANGENTIAL SECTION: Rays simple, containing from 2 to 30 cells, usually 7-9, about 0.02 mm. wide; no bordered pits visible.

OCCURRENCE AND RELATIONSHIPS: While the majority of the specimens of silicified wood show the araucarian type of structure, a few fragments, found at four or five localities, differ in having distinctly separated and more or less opposite bordered pits. According to Kraus's classification, this material should therefore be referred to the genus *Cedroxylon*, as was done in the writer's preliminary report. But the variation in the character of the pits in different parts of the same section suggests its probable identity with the new genus *Brachyoxylon* Hollick and Jeffrey,⁷ in which both alternating double and non-contiguous single rows of pits are present. The occurrence of this type of structure in so early a geological period as the lower Triassic is interesting, although in the absence of any information as to the leaves or other external characters of the plant, discussion of its relationships or significance would be futile.

In searching for evidence as to the age of the "Middle Secondary" rocks in Virginia, Rogers had made a microscopical examination of silicified wood from both "western and eastern belts" and thought its structure "to agree very nearly with the fossils figured by Witham under the name of *Peuce Huttonia*."⁸ He unfortunately never

⁷ Studies of Cretaceous Coniferous Remains from Kreischerville, N. Y., *Mem. N. Y. Bot. Gard.*, III, pp. 54-57, pl. XIII, 1909.

⁸ Witham, H. T. M. *The Internal Structure of Fossil Vegetables*, p. 70, pl. XIV-XV, 1833; reclassified as *Cedroxylon huttonianum* by Kraus: Schimper's *Traité de Paléontologie Végétale*, II, p. 371, 1870.

published the exact localities from which it had been obtained, but it may have been identical with the species here characterized, although in the writer's opinion this is more like *C. lindleyanum* (Witham) Kraus. Both of these species had been described from the Lias of England, and Rogers accordingly inferred the Jurassic age of the American rocks, but there can be no question that our form is really entirely distinct from either, and it is named after the State in which it was discovered.

The distribution of these species is shown in the following table; material from localities M. 2 and M. 3 could not be obtained for study.

Locality.....	B.	1	2	3	4	5	6	7	8	9	10
<i>A. virginianum</i>.....			×	.....	.....	×	.....	.....	.....	.....	.....
<i>A. vanartsdalenii</i>	×	×	×	×	×	×	×	×	×	×	×
<i>B. pennsylvanianum</i>.....	×	×	.....	.....	×	.....	.....	.....	.....	.....	.....

Locality.....	M.	1	2	3	C.1	2	L.1	2	3	Y.1
<i>A. virginianum</i>.....		.....	.....	.....	.....	.....	.....	.....	.....	.....
<i>A. vanartsdalenii</i>.....	×	—	—	.....	×	×	×	×	×	×
<i>B. pennsylvanianum</i>.....		.....	.....	×	×	.....	.....	.....	.....	.....

In conclusion, a word may be added concerning the bearing of the fossil wood on the question as to the climate of the Triassic. A prevailing red color in the sediment of any period has now come to be recognized by geologists as an indication that the climate of the time was to some extent arid. The obscurity of the annual ring in these trees may be regarded as pointing to a certain extent⁹ in the same direction, for it shows that there could not have been any marked seasonal variation in temperature conditions, and the simplest way in which this could occur would be under the prevalence of a dry climate, caused perhaps by some peculiarity of configuration of continents or elevation of mountains, which produced a different circulation of the atmosphere from that prevailing here at present.

The arkosic matrix of the wood specimens (from the feldspar of which their silica has been derived) is also suggestive of the same state of affairs, for it must have been formed under conditions where disintegration exceeded decomposition, so that the feldspar and other silicates could be broken up without extensive chemical alteration, and although this could result equally well in frigid as in arid climates, there is no direct evidence for the former, so that the

⁹ Although the value of this evidence is limited by the fact that living araucarias show little annual ring, even though growing in temperate climates.

latter remains as the most probable climatic condition of the Triassic period in Eastern North America.

EXPLANATION OF PLATES III, IV.

PLATE III.—Fig. 1.—*Araucarioxylon virginianum* Knowlton. Locality B. 5. Transverse section, $\times 20$. No definite annual ring.

Fig. 2.—Same. Radial section, $\times 40$. Shows several double rows of pits.

Fig. 3.—Same. Tangential section, $\times 40$. Shows cross-section of medullary rays and of radial wall pits.

Fig. 4.—*Araucarioxylon vanartsdaleni* sp. nov. Locality B. 5. Transverse section, $\times 20$. No annual ring.

Fig. 5.—Same. Radial section, $\times 40$. Shows one of the very rare double rows of pits.

Fig. 6.—Same. Tangential section, $\times 40$. Shows few-celled rays.

PLATE IV.—Fig. 1.—*Brachyoxylon pennsylvanianum* sp. nov. Locality C. 1. Transverse section, $\times 20$. Shows distinct annual ring of four layers of small cells just above middle.

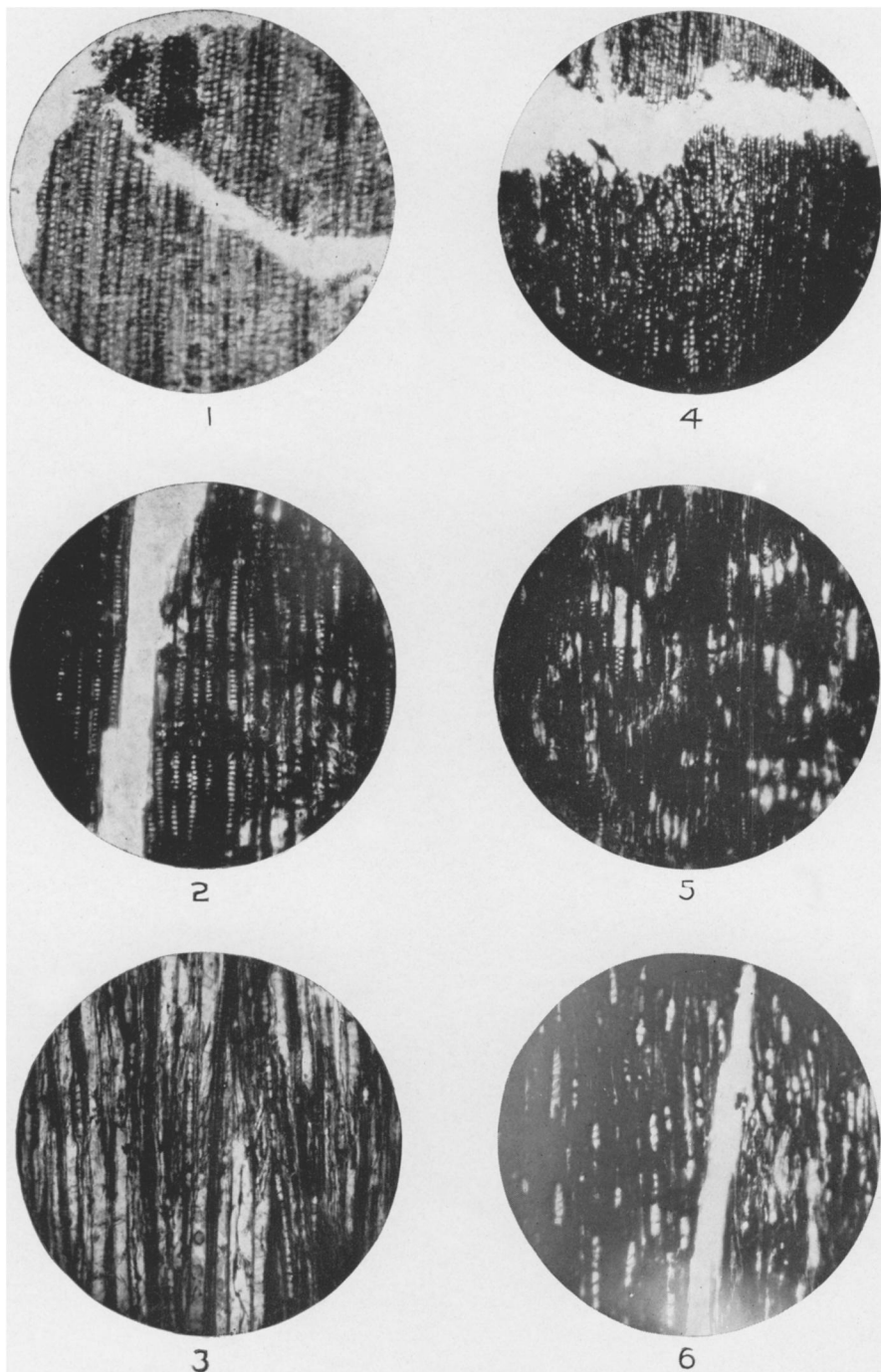
Fig. 2.—Same. Radial section, $\times 40$. Shows single rows of pits, distinctly separated.

Fig. 3.—Same. Tangential section, $\times 40$. Shows medullary rays.

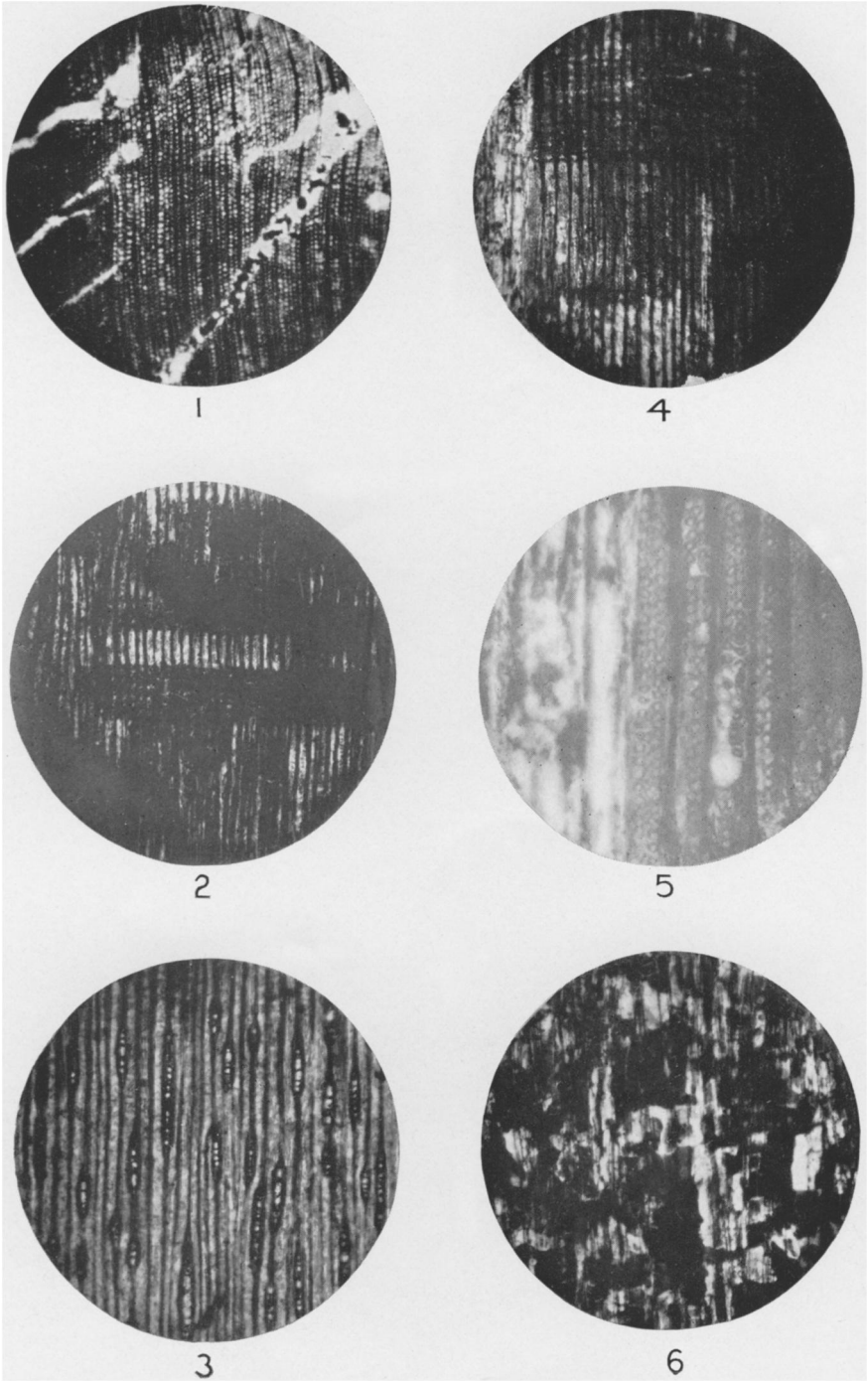
Fig. 4.—Same. Another radial section, $\times 40$. Shows several double rows of pits, which are only partially alternate.

Fig. 5.—Same as figure 4, but $\times 100$.

Fig. 6.—The section shown in Plate III, fig. 3, under crossed nicols ($\times 40$), showing the complete replacement by crystalline quartz.



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